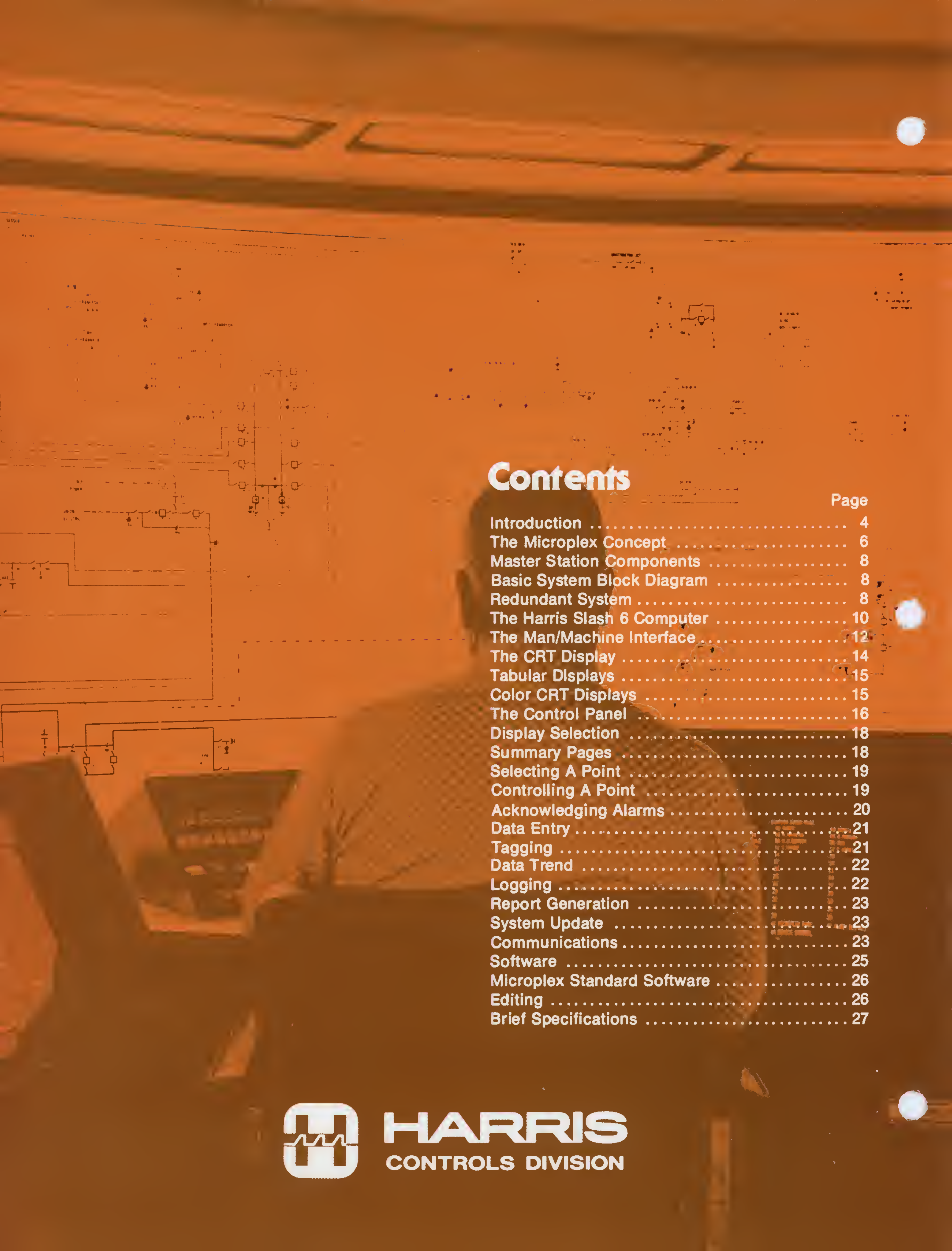
7500 COMPUTER MASTER
SUPERVISORY CONTROL AND DATA ACQUISITION

MICROPLEX®



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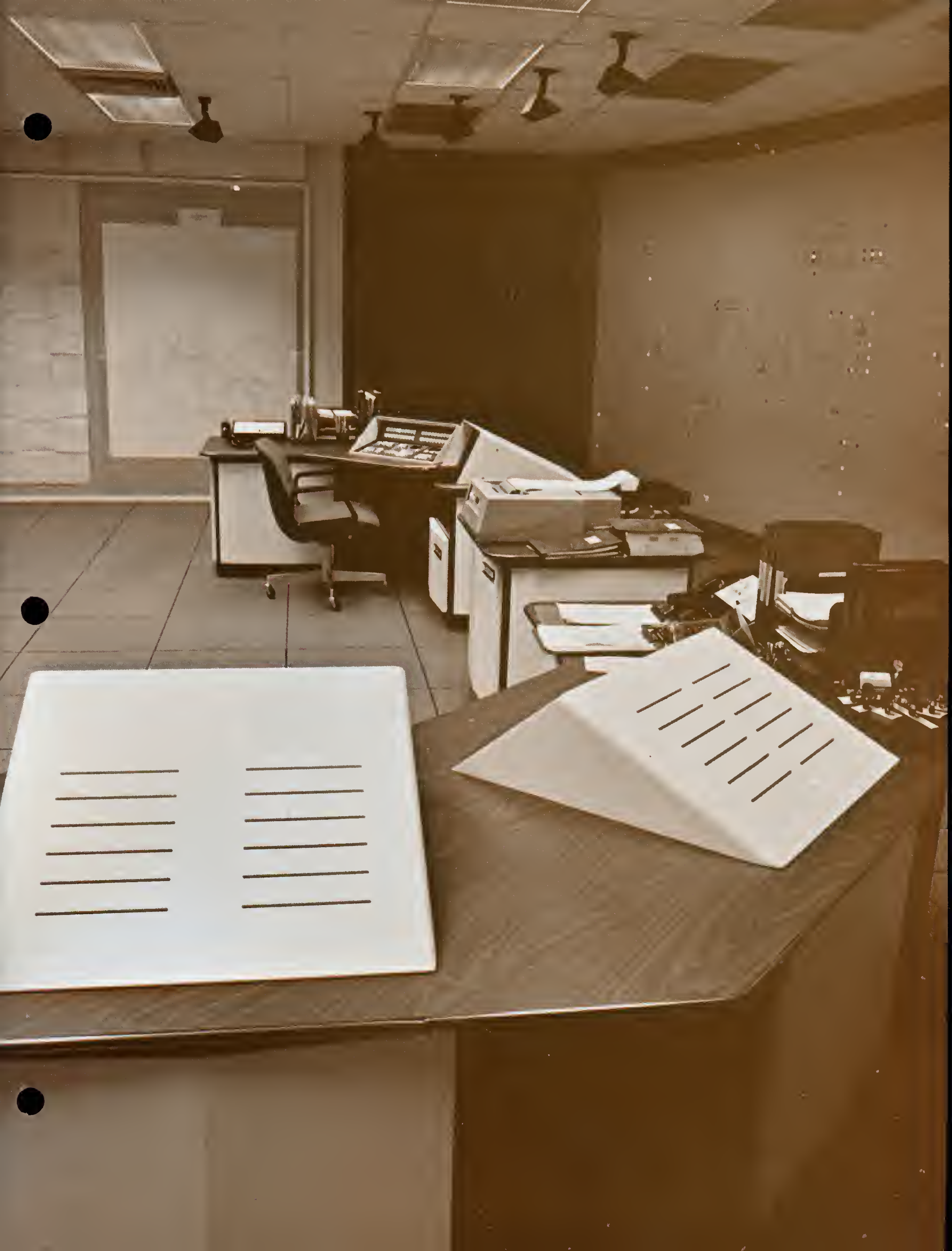
HARRIS
CONTROLS DIVISION



INTRODUCTION

MICROPLEX is one of today's most advanced Supervisory Control concepts. It is based on a computer-centered Master station which is programmed to operate with various types of Remote equipment . . . to offer a great range of capabilities . . . and to provide the system operator with a concise, real-time overview of active, complex networks.

A MICROPLEX system gathers information continuously from remote locations throughout the transmission, distribution, and generating facilities of an electric utility and presents it in various formats and summaries at a centralized control point. Here, operators have a detailed overview of their system, and can utilize the MICROPLEX control console to take quick corrective action as required during routine or emergency situations.

Actual experience with various MICROPLEX installations in past years has shown these systems to be an effective and economical means of handling the daily operation and routine reporting functions associated with transmission and distribution. Similarly, in emergency or abnormal conditions such as weather extremes, the centralized control and monitoring facilities afforded by MICROPLEX have proven to be an effective aid in handling system disturbances and maintaining service.

CONTROL
FUNCTION
LOG START
LOG STOP
LOG PAGE
PAGE FWD
PAGE REV

The Microplex Concept

Today's Supervisory Control and Data Acquisition Systems have evolved toward computer-based, custom-designed equipment with emphasis on large volume data acquisition capabilities. Installations of this type have typically involved extensive engineering and software development on a custom, system-by-system basis. From years of successful experience with such projects, and with an expertise based on more than a half century in the Supervisory Control business, Harris Controls has developed a complete range of economical, standardized, readily-interfaced modular system components . . . operating under a programmable central processor. This concept—MICROPLEX—offers the features and advantages of large, custom-designed systems at a lower initial cost. Yet, a MICROPLEX system is easily expanded as requirements change. It offers "built-in" protection against obsolescence . . . against costly modifications to accommodate system growth and new functional requirements. And because the system is completely modular and highly flexible, the initial installation need only be large enough for present requirements.

Master Station Components

A MICROPLEX 7500 Computer Master consists of three basic units: (1) a Harris Computer, (2) a MICROPLEX Interface Unit, and (3) a MICROPLEX Operator's Console. In addition, there are Loggers and a KSR for program editing. With this equipment as a base, options are selected to suit the functional requirements of a specific application. These options include dual CRT's and individual station select switches for each Remote, dual computers, dual consoles, magnetic tape equipment, color CRT's with one-line schematic displays and data trending, and various input-output peripherals (punched card and paper tape equipment, line printers, etc.). Mapboard drivers, a CPU/CPU link, Intersystem CPU links, and expanded memory up to 256K words can also be supplied. Full redundancy of any or all critical components can be provided. In fact, the possible configurations of a MICROPLEX system are almost limitless.

Basic System Block Diagram

The diagram of a basic system illustrates the simplicity of the MICROPLEX concept. In effect, the Operator's Console, the Logger, the CRT, and the Transceiver Controller are peripheral devices to the Harris Slash 6 Computer. Data are transferred between these devices and the CPU on a Program Input-Output Channel (PIOC) in 8-bit parallel bytes. As many as 16 peripheral devices are addressable by the computer on one PIOC, and the computer can be equipped with 14 such channels. This inherent flexibility is especially beneficial in configuring a MICROPLEX Master to a specific application, and also in expansion or modification of existing systems.

Systems pass data between CPU core and the fixed-head disc by means of a 24-bit Universal Block Controller (UBC) channel. Entire data blocks of up to 65K 24-bit words can be transferred directly to and from the computer under program control without affecting on-line operation.

One Transceiver Controller can handle up to 40 Message Transceivers. These units perform the parallel-to-serial and serial-to-parallel conversions, buffering, and timing required for interface with the Remote equipment.

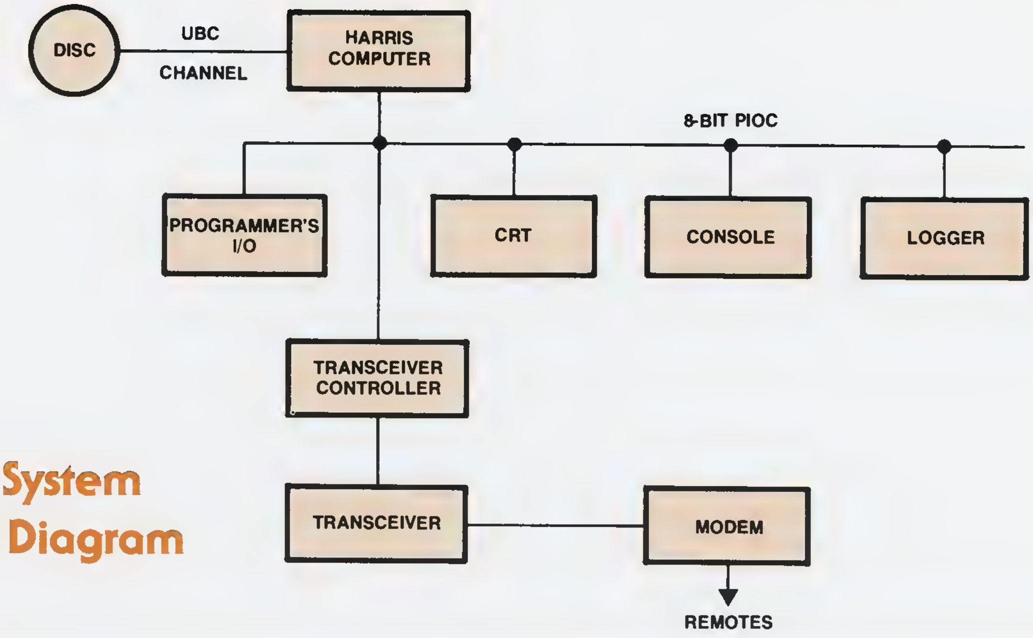
Redundant System

The basic system just described can be expanded into a fully redundant system, as illustrated, in which the dual redundant computer concept is extended to include dual-porting of peripheral devices.

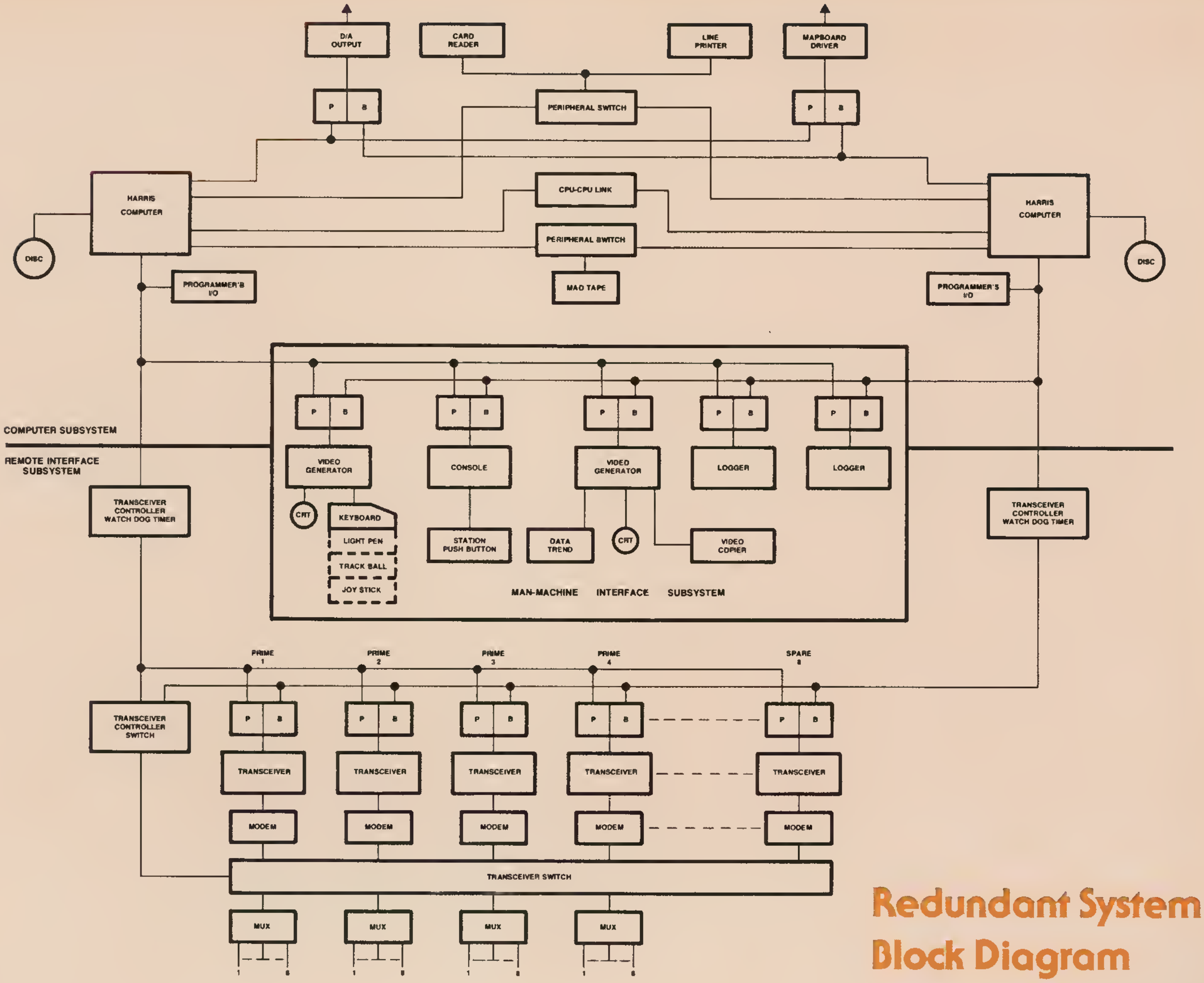
Harris Controls' Dual-Port concept provides for switching of peripherals to either of the two computers, and eliminates the possibility of an element failure affecting the data busses to both CPU's. It also eliminates elements such as NOR gates which could fail in such a way that a peripheral could not be reached by either CPU. Utilizing switched dual-port peripherals thus lowers system costs by providing functional redundancy with less duplication of hardware, and extends the "no single point of failure" concept to the peripheral functions.

Watchdog timers, associated with the Transceiver Controllers, monitor CPU operation continuously. If a computer failure is detected, switchover can be manual or completely automatic.

In the block diagram example, there is also a spare Message Transceiver and a spare Modem. In the event of a failure in this area, automatic switchover would enable recovery. Switchover can also be performed by the Operator through the control panel and CRT, in the same manner as controlling a point.



Basic System Block Diagram



Redundant System Block Diagram

The Harris Slash 6 Computer

The Harris SLASH 6 Computer, utilizing state-of-the-art components and techniques, is the heart of the standard MICROPLEX Supervisory Control and Data Acquisition system. Its memory, data manipulation, and input/output facilities are used to scan the Remote stations and acquire status and data values, maintain the system's data base, process the control and display requests from the Control Console, supply display data and alarm information to the Operator, process all Operator-initiated control functions for Remote points, and prepare al' scheduled or demand Event, Alarm, and Data logs.

With its microprogrammed architecture, modular construction, versatile I/O structure, hardware floating point processor, extensive software and a variety of quality peripheral devices, the SLASH 6 can be configured to meet a wide range of MICROPLEX system requirements.

The SLASH 6 is also software-compatible with larger Harris computers in this series. These large computers are provided in MICROPLEX systems where their increased capacity and performance can be utilized.

The Harris Slash 6 Computer

- 24-bit Word Length
- 450 nsec Semiconductor Memory with Data Save (Battery Backup)
- 768K Bytes (Maximum) in 48K Byte Increments
- Single-Bit Error Correction (5-Bit Hamming Code Technique)
- Hardware Multiple/Divide/Square Root
- Priority Interrupt Control System
- 24 Maximum External Priority Interrupt Levels.
- Power Failure Shutdown and Restart
- Eight Bootstraps
- 120 HZ Clock
- Programmer's Control Panel
- Program Restrict and Instruction Trap
- Bit Processor, Stall Alarm, and Executive Traps (with option board)
- Universal Block Channel (UBC)

The Man/Machine Interface

The MICROPLEX man-to-machine interface is designed to be adaptive to specific requirements, and for this reason it is quite flexible. It consists of the following basic equipment:

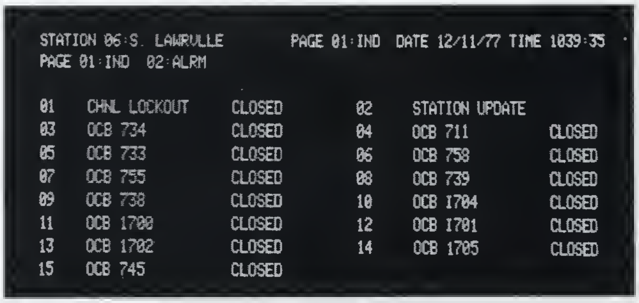
- Cathode Ray Tube Displays (one or two per console; black and white or color)
- Control Panels with Pushbuttons and Indicators
- Event Loggers
- Data Loggers
- Audible Alarms

System size and functional requirements will dictate the number and type of CRT's, loggers, operator consoles, use of tabular and schematic display formats, and the addition of cursor and lightpen features to the basic equipment. Mapboard driver circuitry can be included, in order to provide dynamic status and alarm information for designated points on a large, wall-type display.

The CRT display, control panel, and loggers interact to provide a highly effective overview of the supervised system . . . with instant access to individual "pages" of a Remote station's information or to condensed summaries of alarms and abnormal conditions. The system operator is presented with tabulated, real-time data which he can assimilate at a glance. He is not concerned with the inner workings of the Supervisory Central Processor; he is aware only of the quick, effortless callup and display of the information he selects. Simple and logical operating procedures allow him to quickly operate devices at Remote stations or to perform local operations such as limits modification. He senses a direct flow of select-before-control signals to the particular device or point he designates. Event and Data loggers provide permanent hard copy records as events occur, and perform routine data logging periodically and on demand.

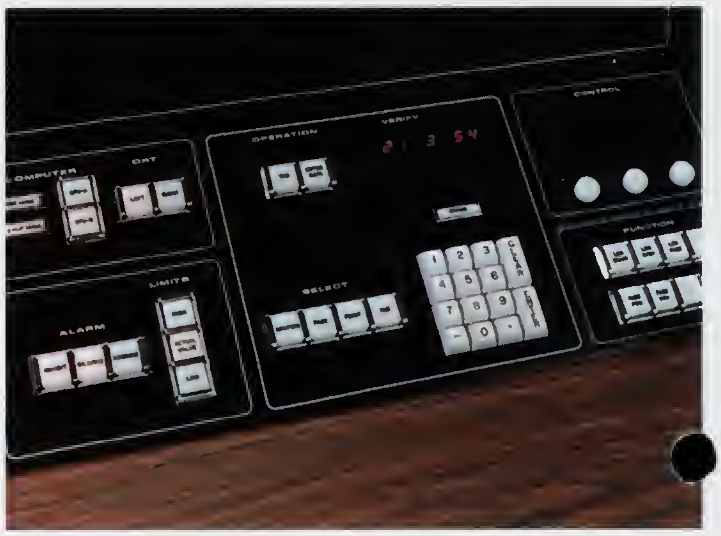
The design of the MICROPLEX Control Panel includes full provisions for system security, thus, the panel does not accept illegal or improper commands. Moreover, all control sequences must be begun and completed within a specific timed aperture. Point selection and command sequences are arranged so that the operator can move deliberately to make the panel entries, verify that each entry is correct, and only then execute a control function. All messages between the CPU and the operator's console are protected by message security techniques.

The basic concept of the MICROPLEX Man/Machine interface is such that it is even possible to operate a console without benefit of CRT displays. The loggers can serve as the operator's "display". As changes occur, they are logged, along with the point's nomenclature, station, page, and line numbers. A page log can also be called to obtain current status and values. In this manner, the operator is kept aware of changes and can perform Control functions as required.



```
STATION 06:S. LAWRVLLE          PAGE 01:IND  DATE 12/11/77 TIME 1039:35
PAGE 01:IND  02:ALRM

01   CHNL LOCKOUT    CLOSED      02   STATION UPDATE
03   OCB 734         CLOSED      04   OCB 711         CLOSED
05   OCB 733         CLOSED      06   OCB 758         CLOSED
07   OCB 755         CLOSED      08   OCB 739         CLOSED
09   OCB 738         CLOSED      10   OCB 1704        CLOSED
11   OCB 1700        CLOSED      12   OCB 1701        CLOSED
13   OCB 1702        CLOSED      14   OCB 1705        CLOSED
15   OCB 745         CLOSED
```



The CRT Display

MICROPLEX systems can utilize three types of displays:

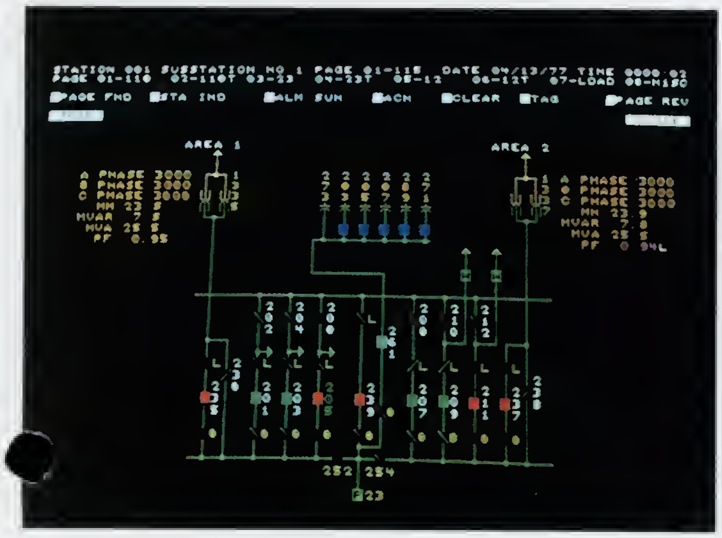
- Tabular alphanumeric displays,
- Schematic diagrams,
- Data trend charts.

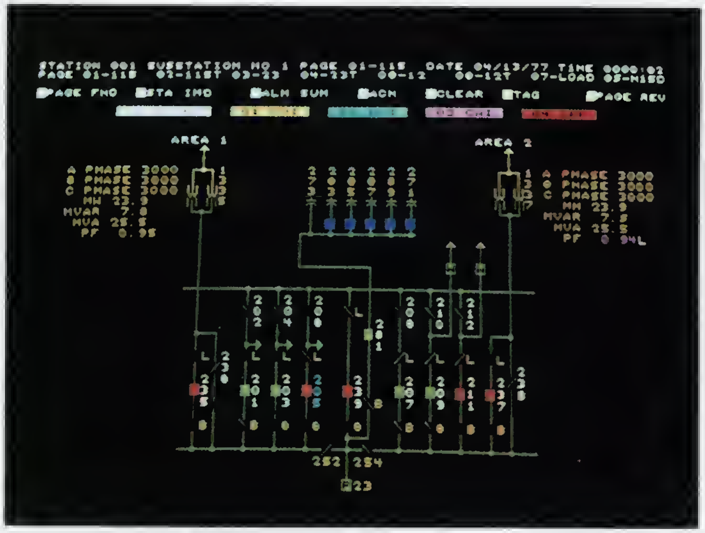
Tabular displays consist of pages listing alphanumeric information which reflects the status of that part of the system being viewed. Schematic (one-line) diagrams are simplified diagrams of specific portions of the supervised system; and the video data trend feature provides graphs in strip-chart form on a color CRT.

In MICROPLEX systems using alphanumeric tabular displays exclusively, a high-quality 17-inch black-and-white CRT unit can be utilized. This display provides 20 80-character lines, with highly legible 1/4-inch high characters formed by a 5x7 dot matrix.

Using color CRT displays in a MICROPLEX system can enhance the effectiveness of the Man/Machine interface. Highly informative, full-color schematics and diagrams, bearing real-time, dynamic status and data values, are presented to the operator to supplement the conventional tabular formats, significantly improving an operator's overview of a complex system. With the data trend feature, dynamic graphs are displayed similar to strip-charts. As many as four data quantities are shown on one page, with the system operator selecting points to be displayed.

Depending on the specific model selected, color CRT's can display either 7 or 8 colors, plus blinking, on 48 lines of 72 characters each. There are up to 192 characters in a set; including alphabetical, numerical, punctuation, and graphic symbols for schematic diagrams.




STATION 001 SUBSTATION NO 1 PAGE 01-115 DATE 04/13/77 TIME 0000:02
PAGE 01-110 02-110T 03-23 04-23T 05-12 06-12T 07-LOAD 08-M150
PAGE FWD
STA IND
ALM SUM
ACK
CLEAR
TAG
PAGE REV
AREA 1
AREA 2
A PHASE 3000
B PHASE 3000
C PHASE 3000
252
254
23

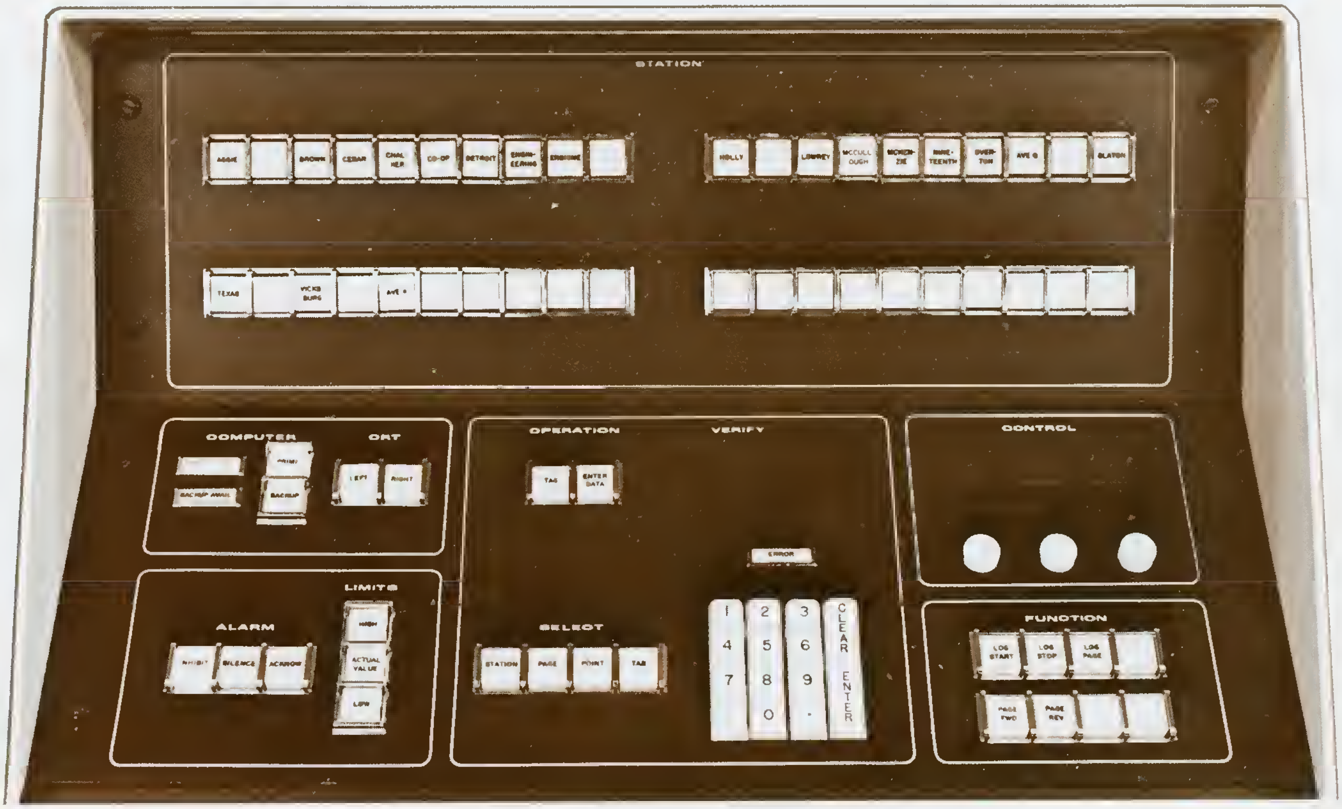
Tabular Displays

The basic display in a MICROPLEX system is a tabular page of real-time alphanumeric information which reflects the status of that part of the system being viewed. On a black and white CRT, an alarm, or other event which requires operator action, is made conspicuous by "blinking"—flashing on and off—the point's state; and also by presenting it in reverse video (black characters on a white background). Reverse video alone indicates an abnormal condition. It is also used to indicate that a point has been selected by reversing the point's identification.

System level page types include a Station Index page, a MICROPLEX System page, an Alarm Summary, Abnormal Summary, and Tab Summary pages. Remote stations having more than a few points will usually be displayable on three tabular pages: Status (also Control), Alarm, and Data. Station pages can be formatted with status, alarm, and data points mixed if desired.

Color CRT Displays

Color CRT displays are utilized in MICROPLEX systems which have capability for one-line schematic diagrams, Data Trending, and other such functions where the use of color is advantageous. Various types of information are shown in white and different colors in order to define or separate the types of information. Basic tabular, alphanumeric pages are displayed in white on a color CRT, with the exception that abnormal conditions are indicated by the magenta color and blinking, and selected points are indicated by the green color.



The Control Panel

Because MICROPLEX was designed to relieve the system operator of repetitive, distracting, non-essential tasks, the control panel is highly simplified. Operating procedures are very logical and direct. Just as flashing (blinking) information on the CRT screen signals an alarm to the operator, appropriate pushbuttons and indicators on the panel blink to further direct his attention and response.

Using a familiar 12-button numerical keyset, the operator can call up any display, select a point, enter limits or setpoint data, or flag and inhibit designated points. A digital readout allows positive verification of entries. The control panel functions can also be supplemented with controls for a cursor on the CRT displays, or an interactive lightpen.

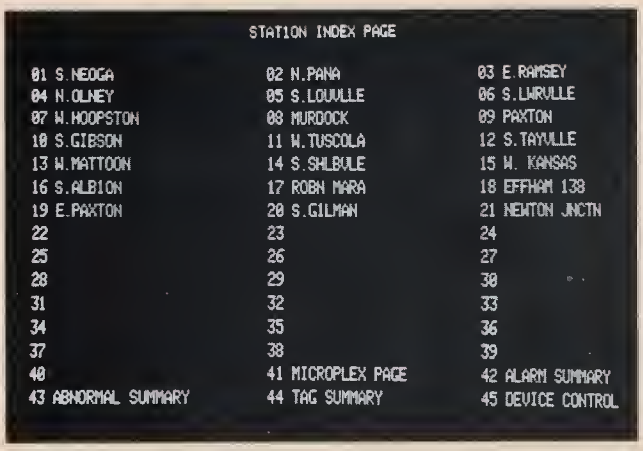
VERIFY
PERATION
TAG
ENTER DATA
ERROR
SELECT
ON
PAGE
POINT
TAB
1
2
3
CLEAR
4
5
6
7
8
9
—
0
.

Display Selection

A Station Index appears on the CRT whenever the STATION button is depressed. Immediately when a station is selected, the station's first page—typically STATUS (or IND)—is displayed on the CRT. The 2-line header on each page identifies the station and page, and gives the date and time. Further, it lists all pages for that station up to a total of eight.

To call another page of a station, the operator presses the Page button and keys in the page number or utilizes Page Forward, Page Reverse pushbuttons.

Display selection during alarm situations is especially quick . . . almost an instinctive reaction. When an unacknowledged alarm exists at a station, the station name blinks on the index page. Keying in that station number automatically calls the page on which the alarm has occurred. If the Master is equipped with individual Station Select/Indicator buttons, an alarming point at any station also causes that station button to blink. A station can then be selected merely by pressing that station button.



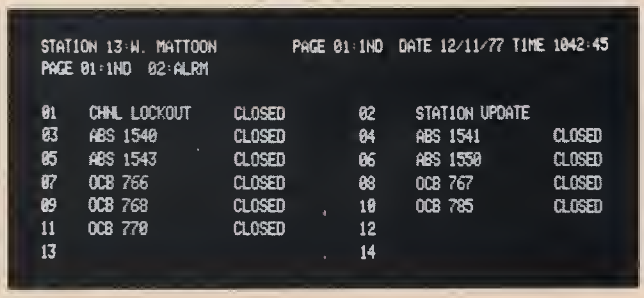
```
                         STAT1ON INDEX PAGE

01 S.NEOGA               02 N.PANA               03 E.RAMSEY
04 N.OLNEY               05 S.LOUVLLE            06 S.LWRVLLE
07 W.HOOPSTON            08 MURDOCK              09 PAXTON
10 S.GIBSON              11 W.TUSCOLA            12 S.TAYVLLE
13 W.MATTOON             14 S.SHLBVLE            15 W. KANSAS
16 S.ALB1ON              17 ROBN MARA            18 EFFHAM 138
19 E.PAXTON              20 S.G1LMAN             21 NEWTON JNCTN
22                       23                      24
25                       26                      27
28                       29                      30
31                       32                      33
34                       35                      36
37                       38                      39
40                       41 MICROPLEX PAGE       42 ALARM SUMMARY
43 ABNORMAL SUMMARY      44 TAG SUMMARY          45 DEVICE CONTROL
```

Station Index Page

In systems employing one-line diagrams on Color CRT's and having the cursor or lightpen feature, the operator is provided with labeled, defined areas in the heading of the displayed page which correspond to the conventional controls on the operator panel. Simply pressing the lightpen on the desired area (or placement of the cursor) will cause the selected display page to be shown. The same straightforward procedures and logical responses designed into the basic MICROPLEX man/machine interface are thus carried over into lightpen or cursor control.

When the Station Index is on the CRT, the lightpen can be applied to the station identification to call the appropriate station display.



```
STAT1ON 13:W. MATTOON          PAGE 01:1ND  DATE 12/11/77 T1ME 1042:45
PAGE 01:1ND  02:ALRM

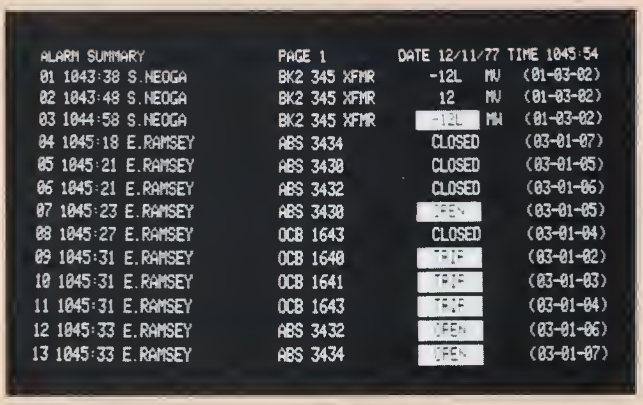
01    CHNL LOCKOUT    CLOSED        02    STAT1ON UPDATE
03    ABS 1540        CLOSED        04    ABS 1541         CLOSED
05    ABS 1543        CLOSED        06    ABS 1550         CLOSED
07    OCB 766         CLOSED        08    OCB 767          CLOSED
09    OCB 768         CLOSED        10    OCB 785          CLOSED
11    OCB 770         CLOSED        12
13                                  14
```

Typical Tabular Page

Summary Pages

The Alarm Summary page contains a chronological listing of all unacknowledged alarms. The oldest alarm is listed first. When an alarm is acknowledged, it is removed from the list and the remainder of the list is shifted up. Since every line on this page denotes an alarm, blinking is not used.

The Alarm Summary lists alarming points with the time of occurrence at the left; and station, page, and display area location at the right. With this page on display, the operator can acknowledge any individual alarm, or all alarms on the page.



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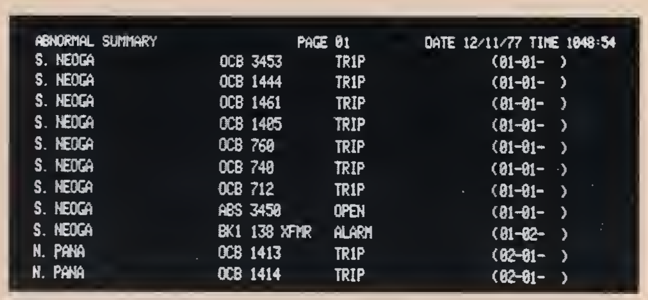
ALARM SUMMARY                PAGE 1        DATE 12/11/77 TIME 1045:54
01 1043:38 S.NEOGA           BK2 345 XFMR     -12L   MW   (01-03-02)
02 1043:48 S.NEOGA           BK2 345 XFMR      12    MW   (01-03-02)
03 1044:58 S.NEOGA           BK2 345 XFMR     -12L   MW   (01-03-02)
04 1045:18 E.RAMSEY          ABS 3434         CLOSED      (03-01-07)
05 1045:21 E.RAMSEY          ABS 3430         CLOSED      (03-01-05)
06 1045:21 E.RAMSEY          ABS 3432         CLOSED      (03-01-06)
07 1045:23 E.RAMSEY          ABS 3430         OPEN        (03-01-05)
08 1045:27 E.RAMSEY          OCB 1643         CLOSED      (03-01-04)
09 1045:31 E.RAMSEY          OCB 1640         TRIP        (03-01-02)
10 1045:31 E.RAMSEY          OCB 1641         TRIP        (03-01-03)
11 1045:31 E.RAMSEY          OCB 1643         TRIP        (03-01-04)
12 1045:33 E.RAMSEY          ABS 3432         OPEN        (03-01-06)
13 1045:33 E.RAMSEY          ABS 3434         OPEN        (03-01-07)
```

Alarm Summary



```
ABNORMAL SUMMARY                  PAGE 01          DATE 12/11/77 TIME 1048:54
S. NEOGA                OCB 3453     TRIP                 (01-01-  )
S. NEOGA                OCB 1444     TRIP                 (01-01-  )
S. NEOGA                OCB 1461     TRIP                 (01-01-  )
S. NEOGA                OCB 1405     TRIP                 (01-01-  )
S. NEOGA                OCB 760      TRIP                 (01-01-  )
S. NEOGA                OCB 740      TRIP                 (01-01-  )
S. NEOGA                OCB 712      TRIP                 (01-01-  )
S. NEOGA                ABS 3450     OPEN                 (01-01-  )
S. NEOGA                BK1 138 XFMR ALARM                (01-02-  )
N. PANA                 OCB 1413     TRIP                 (02-01-  )
N. PANA                 OCB 1414     TRIP                 (02-01-  )
```

Abnormal Summary

The Abnormal Summary lists all abnormal conditions which exist on the system. This display, and a corresponding logger page, can be used as a quick system overview at such times as operator shift changes. It is for monitoring only and does not provide any control functions. Abnormal points are arranged by station, without reference to time.

The Tag Summary page lists all tag assignments in the system.

The MICROPLEX page provides a means to set the system's time-of-day clock, date, frequency of automatic logs, and various other system-oriented functions.

The Device Control page permits operator switching of communications transceivers and control of such local system devices as required by the particular installation.

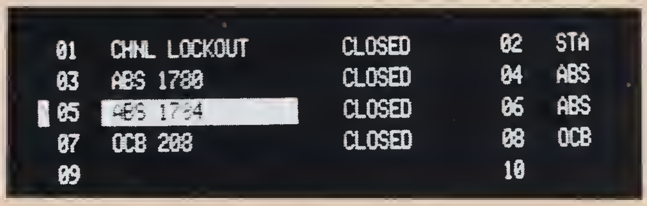
Selecting A Point

When a page is on display on the active CRT, any point can be easily and quickly selected in order to acknowledge an alarm, control the point, set limits, and set or cancel tags. If a point is selected, the MICROPLEX system responds with certain indications of allowable operations, depending on the type of point.

When points are displayed, one-per-line on tabular displays, a point is selected by entering the line number for that point. The MICROPLEX system responds by placing an arrow at the selected point, and enhancing the point name. An adjustable programmed timer cancels the selection after approximately 20 seconds; or the operator can cancel it immediately by pressing POINT.

If there is more than one point on a line, the point selection can be moved to the next point to the right by pressing the TAB button. The arrow and enhancement will move to the selected point automatically.

On color CRT displays with one-line diagrams, selectable points are identified by a white 2-digit number adjacent to the point. Selection of a point by control panel, cursor, or lightpen is confirmed when the point identification number turns green (or flashes).



```
 01  CHNL LOCKOUT        CLOSED       02  STA
 03  ABS 1780            CLOSED       04  ABS
▌05  ABS 1784            CLOSED       06  ABS
 07  OCB 208             CLOSED       08  OCB
 09                                   10
```

Selected Point

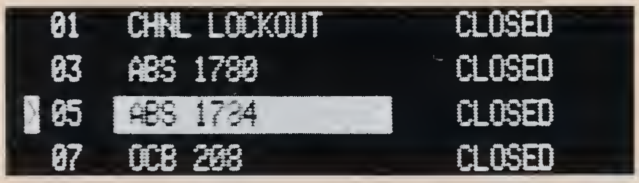
Controlling A Point

To control a point, the page containing the point . . . usually the Status page . . . is displayed on the active CRT and the point is selected. The operator can then confirm his selection of the desired point by the presence of the select arrow and the enhanced point name, or by the green color. At the same time, the rear projection indicators in the CONTROL area light to display only the two (or three) allowable control functions for that point.

The operator can then press the pushbutton below the appropriate indicator, which executes the control function and deselects the point. A moment later, he will see the result of his action when the changed status is returned on the CRT display. However, an alarm indication is given for the point if the controlled device fails to operate.

With a lightpen, the series of allowable control functions for the selected point is projected on the screen. Placing the lightpen on the desired function executes the command.

An adjustable timer allows up to 20 seconds for the select-before-operate sequence, and resets the point selection if the operator does not control the point within the timed aperture.



```
01  CHNL LOCKOUT        CLOSED
03  ABS 1780            CLOSED
05  ABS 1724            CLOSED
07  OCB 208             CLOSED
```

Controlling A Point

Some typical control indicator displays are as follows. This nomenclature can be varied to comply with convention for different installations:

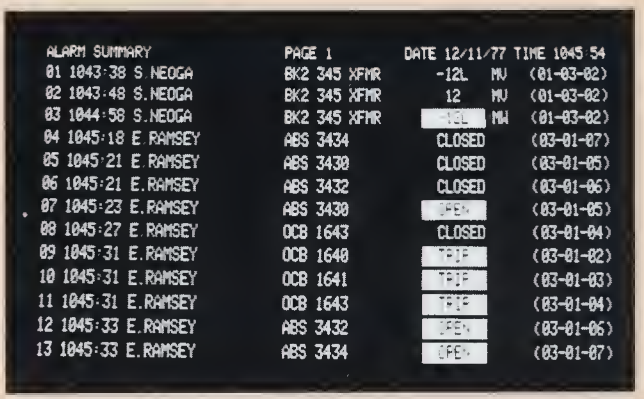
Point Type	Left	Center	Right
OCB	TRIP	———	CLOSE
ABS	OPEN	———	CLOSE
TAP CHANGER	RAISE	CANCEL	LOWER
DATA (LIMIT)	———	ENTER DATA	———
TIME or DATE	———	ENTER DATA	———
STATION UPDATE	———	———	START

Acknowledging Alarms

The MICROPLEX operator has the option of acknowledging alarms one-by-one or by an entire page.

Regardless of what station or page within the system is on display, the MICROPLEX operator can quickly select a display, assess the situation, and acknowledge the alarm conditions. If an alarm point changes to alarm condition, a measurement goes beyond its limit, a controllable point changes state other than on command, or if a controllable point does not change state on command, the system will immediately alert the operator. The audible alarm will sound, and an alarm log will be made on the events logger.

If desired, the audible alarm can be silenced without acknowledging the alarm by pressing the SILENCE button in the ALARM area of the panel. Additionally, the operator can disable further audible alarm signals by pressing INHIBIT. In any case, the SILENCE button will flash to indicate an alarm.



```
ALARM SUMMARY                    PAGE 1        DATE 12/11/77 TIME 1045:54
01 1043:38 S.NEOGA               BK2 345 XFMR      -12L   MV   (01-03-02)
02 1043:48 S.NEOGA               BK2 345 XFMR       12    MV   (01-03-02)
03 1044:58 S.NEOGA               BK2 345 XFMR      -12L   MW   (01-03-02)
04 1045:18 E.RAMSEY              ABS 3434         CLOSED       (03-01-07)
05 1045:21 E.RAMSEY              ABS 3430         CLOSED       (03-01-05)
06 1045:21 E.RAMSEY              ABS 3432         CLOSED       (03-01-06)
07 1045:23 E.RAMSEY              ABS 3430          OPEN        (03-01-05)
08 1045:27 E.RAMSEY              OCB 1643         CLOSED       (03-01-04)
09 1045:31 E.RAMSEY              OCB 1640          TRIP        (03-01-02)
10 1045:31 E.RAMSEY              OCB 1641          TRIP        (03-01-03)
11 1045:31 E.RAMSEY              OCB 1643          TRIP        (03-01-04)
12 1045:33 E.RAMSEY              ABS 3432          OPEN        (03-01-06)
13 1045:33 E.RAMSEY              ABS 3434          OPEN        (03-01-07)
```

Alarm Acknowledgment

To identify the causes of alarms, the operator can display the Alarm Summary page which will contain all unacknowledged alarms throughout the system together with their location (station, page, and line). Alternatively, he can go directly to the affected station display page by keying in the station index number, or by pressing the appropriate station select button if so equipped.

In order to expedite display selection during an alarm situation, selecting a Station automatically calls the first page containing an unacknowledged alarm.

Every remote station display page contains a list of all pages for that station on the display's second line. Pages containing alarms are annunciated by blinking this page identification. All points in alarm will appear with their current status flashing, except on the Alarm Summary page.

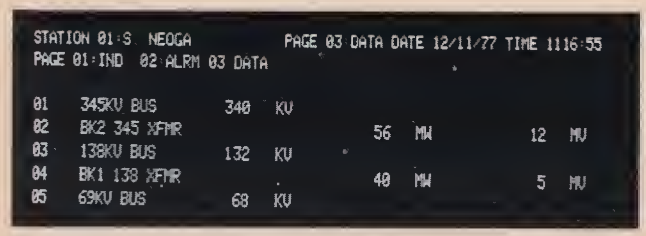
To acknowledge all alarms on a displayed page, the operator presses the ACKNOWLEDGE button. He can acknowledge multiple alarms in the system simultaneously by displaying Alarm Summary pages and pressing ACKNOWLEDGE. To acknowledge points individually, the operator must first select the point. The acknowledgement will then affect only that point.

On a one-line diagram type page with systems having a lightpen, all alarms on the page can be acknowledged by use of the ACK selection area. Note also that the Alarm Summary page can be called directly from any one-line page.

Data Entry

Any analog point can be assigned a high limit and a low limit, which will cause alarms if exceeded.

The MICROPLEX operator can observe the high and low limits settings for the data points of a page on display by depressing the HIGH or LOW button in the LIMITS area. This causes the actual data to be replaced on the CRT by the limit value and the letter "H" or "L" as appropriate. To change a limit, the operator selects the point, presses ENTER DATA, and enters and verifies the new limit at the numeric keyset. The display is returned to normal by pressing ACTUAL VALUE.



```
STATION 01:S NEOGA                 PAGE 03 DATA DATE 12/11/77 TIME 1116:55
PAGE 01:IND  02:ALRM 03 DATA

01    345KV BUS        340   KV
02    BK2 345 XFMR                     56   MW              12   MV
03    138KV BUS        132   KV
04    BK1 138 XFMR                     40   MW               5   MV
05    69KV BUS          68   KV
```

Data Page

A set point value is entered or changed by selecting the appropriate point, keying in and verifying the new value, and pressing the control button over which ENTER DATA is displayed.

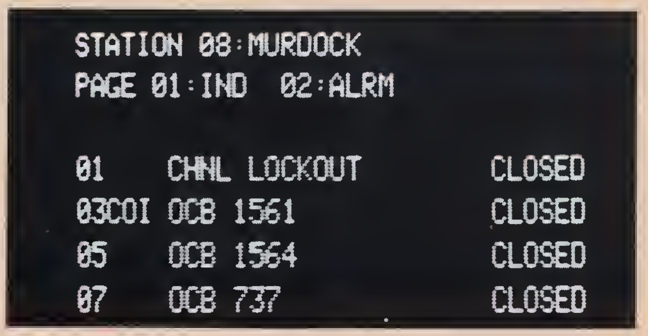
A further type of data entry allows a displayed value to be replaced by a keyed-in value; as, for example, when it is desired to substitute a known value during logging for a value from a device known to be malfunctioning. However, the acquired value will again replace the keyed-in value at the next scan unless the Remote is placed off-line.

Data Verification

There are four points on the MICROPLEX page where data can be entered; point 01, where the date is set; point 02, where the current time is set; point 07, where the time for the next automatic system log is set; and point 08, where the automatic log frequency is set. Data is entered or changed at any of these points by selecting the point, keying in the new data, as previously described.

Tagging

The operator can inhibit the alarm function or the control operation, or both, for any point. Status Update, normally the first point position of each station's first page, can be inhibited in order to prevent scanning that Remote. Inhibited points are designated with a 3-letter "tag" adjacent to the point identification number, or by the color of the point identification number on color one-line diagrams.



```
STATION 08:MURDOCK
PAGE 01:IND  02:ALRM

01     CHNL LOCKOUT          CLOSED
03COI  OCB 1561              CLOSED
05     OCB 1564              CLOSED
07     OCB 737               CLOSED
```

Tagged Point

To set a tag, the operator selects the point, presses the TAG button, and enters the appropriate tag code; or if using a lightpen on a one-line diagram page, the lightpen is applied to the desired tag when it is displayed. Tag codes are as follows:

Tag Code	B&W Display	Color Display	Definition
00	Blank	White	Delete Tag
01	COI	Yellow	Control Inhibited
02	ALI	Aqua	Alarm Inhibited
03	CAI	Magenta	Control and Alarm Inhibited
04	OFF	Not Used	Station or Point Scan Inhibit

Data Trend

The data trend feature, available on MICROPLEX systems having color CRT's, allows the system operator to assign data points to two types of dynamic, graph-type color CRT displays.

There are two types of trending: historical, in which a continually refreshed 256-sample history for a point is maintained; and real-time, in which sampling begins only when the point is called for display.

A series of entry pages can be called by the operator, on which he can assign specific points to either type of display. Four points can be included on each display page. The operator can select a sampling rate for a point ranging from seconds through months. He can enter scaling, high/low limits, baseline, and magnification information; and can specify whether the area on the graph beneath the variable is to be shaded. Thus he can develop a series of highly informative graphs of analog data, arranged by page with up to 4 points per page, which can provide instant visual comparisons and evaluations of a large number of variable trends in his system.

Each of the four tracks per page is a different color, and baselines can be spaced as required or superimposed. When limits are set, the portion of a shaded area which is out of limits is shown in red.

Historical and real-time data trend displays are listed on the Station Index display, and are called in the same manner as stations.

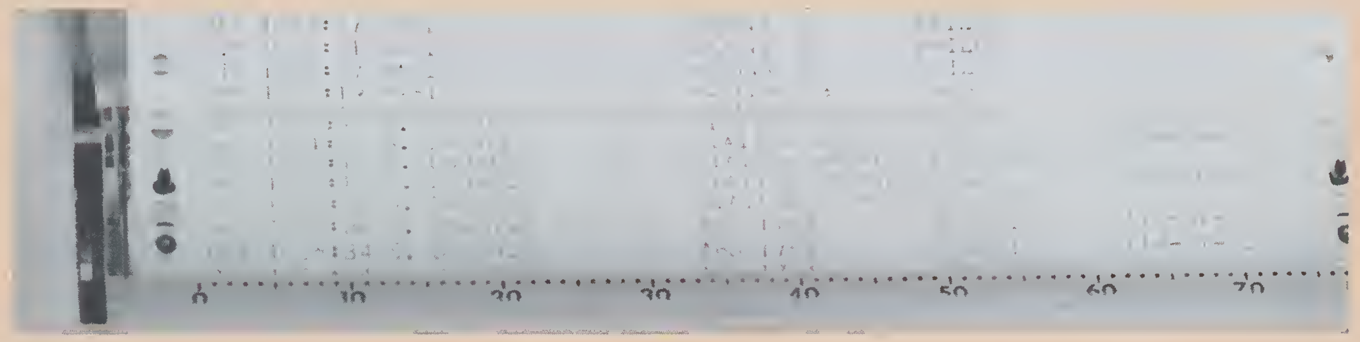
Logging

The events logger will log any significant change in the system and operator actions. These include:

- Any change in the state of a device
- Any change in an alarm point
- An analog point which exceeds limit or returns within limit
- Communications failure (no reply, invalid reply) from Remote stations
- Control operations on Remote station points by the operator
- Operator adjustment of limit settings
- Tag Operations

The MICROPLEX system can periodically and automatically perform predefined system level logs. The log can also be started at any time by selecting the Station Index page and pressing the LOG START button in the COMMAND area. If only one station's log is wanted, the desired station is selected first.

The status of a substation can be logged by calling the station's Status page to the CRT and pressing



Typical Log

PAGE LOG. Any CRT page can be logged in this manner. As logs proceed, the current status and analog values are printed; that is, the current status of the point at the time the computer formats the line for logging is used rather than the status at the time the log was initiated. This assures that logs contain data or status which is fresh at the time the log is formatted.

Any log in progress can be aborted by pressing the LOG STOP button. If another log has been requested, the computer will begin that log after aborting the log in progress.

Report Generation

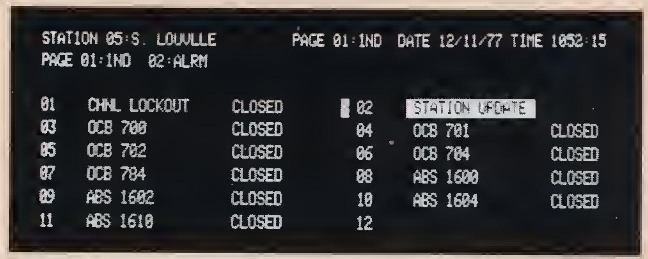
The MICROPLEX Report Generation System (RGS) is a desirable addition to the basic Master which enables the customer to design almost any type of special report or tabulation of data for automatic or on-demand output by the system.

All inputs to an RGS report are obtained from the MICROPLEX data base. Any data quantities or accumulator readings can be used, including dispatcher-entered quantities. The data can be used in calculations, and the results included in the report . . . which can be output on loggers, recorded on mag tape, or produced on a line printer.

Because it is possible to custom design an RGS report to almost any requirement using an easily understood, conversational-type editor program, it can be an extremely valuable tool in management information systems, operating studies, and statistical recording. The ready availability of selected data, plus the computational facilities of the SLASH series computer, means that RGS can save endless hours of tedious clerical work. Opportunities for human error are eliminated, and management can be supplied with timely, concise summaries of operating data.

System Update

The operator can call for all status and data to be updated (scanned) at a Remote station by selecting the Station Update point on the station's Status page. A control indicator will display the word START. Pressing the control button will initiate the update.



```
STATION 05:S. LOUVLLE            PAGE 01:1ND  DATE 12/11/77 TIME 1052:15
PAGE 01:1ND  02:ALRM

01   CHNL LOCKOUT      CLOSED        02   STATION UPDATE
03   OCB 700           CLOSED        04   OCB 701            CLOSED
05   OCB 702           CLOSED        06   OCB 704            CLOSED
07   OCB 704           CLOSED        08   ABS 1600           CLOSED
09   ABS 1602          CLOSED        10   ABS 1604           CLOSED
11   ABS 1610          CLOSED        12
```

Updating A Remote

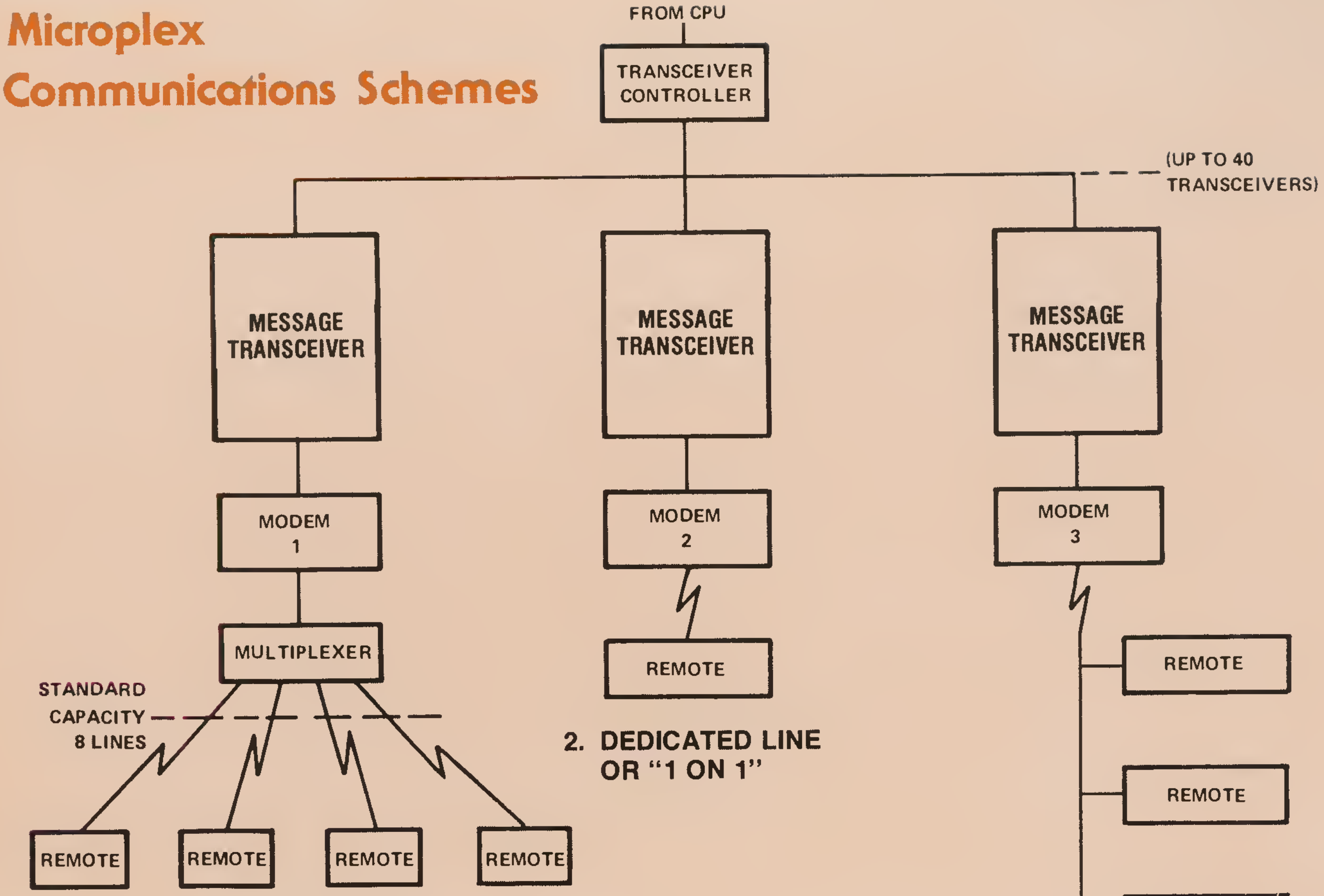
The entire system can be updated in a similar manner by selecting the SYSTEM UPDATE point on the MICROPLEX page and controlling it to start as above.

Communications

A MICROPLEX Master is supplied with Transceivers and software to accommodate specified Remote equipment, and with modems and/or telegraph channel interface units for connection to the user's communications facilities. These facilities can be any Full Duplex (4-wire) or Half Duplex (2-wire) telegraph, voice-grade, telephone, microwave, or power-line carrier communications link that meets the user's requirements. The mode is always Half Duplex, although the use of Full Duplex channels reduces turn-around time, increasing the effective scan rate somewhat in higher speed applications. MICROPLEX can utilize any modems and line rates from 30 b/s to 9600 b/s. However, the available communications facilities, the number and types of Remote equipment, and the desired system scan rates will dictate the optimum communications scheme for a specific application.

Telegraph-grade channels are designed for use with 60 or 20 milliampere loops, with optional lightning arrestor/line surge protection. Tone-equipment channels use standard asynchronous modems (Bell Type 202 or equivalent). Data transfer is asynchronous, NRZ (non-return-to-zero), and serial by bit, using FSK (frequency shift keyed) modulation.

Microplex Communications Schemes



1. MULTIPLEXING

2. DEDICATED LINE OR "1 ON 1"

3. PARTY LINE

Typically, operation at rates up to 1200 b/s is over unconditioned, type 3002, voice-grade circuits. With C2 line conditioning, rates of up to 1800 b/s are obtained. The higher rates, 2400 to 9600 b/s, require progressively more line conditioning and better facilities.

Any detectable problem with Remote station communications will be logged, and will cause an Alarm for the station. The system counts the number of times a "no reply" (failure to respond to a scan request) occurs for a Remote and provides an alarm after a set number of failures. The allowable number of "no replies" is programmable, and can be selected in accordance with expected communications conditions and as appropriate for the system scan rates. Security coding errors, message length errors, and all such transceiver sequence errors are detected, logged, and brought to the operator's attention. Displayed data is tagged with a "#" sign to indicate that it was not updated on the last scan.

A MICROPLEX Master can accommodate from one to 40 transceivers. Each transceiver can accommodate only one communication format; that is, each different Remote equipment type requires a separate transceiver module.

However, up to eight lines can be multiplexed on one modem and multiple Remote locations can be "party lined" on one line.

Thus the MICROPLEX concept allows great flexibility in configuring the specific Master-to-Remote communication network so as to take maximum advantage of available facilities. This also permits more effective adaptation of the Master to specific requirements. For instance, an application requiring high scan rates might utilize dedicated circuits to individual Remote locations with only one Remote on a modem. Since there are 40 transceiver/modem channels available, such a system could scan 40 Remotes simultaneously. At the other extreme, 5 channels could each be multiplexed to eight Remote circuits—again, a total of 40, but requiring only five equipped channels and modems at the Master station. Such a configuration would have a scan rate eight times slower.

Software

MICROPLEX software is built around a Data Base. Each of the major program functions communicate with each other primarily through the Data Base.

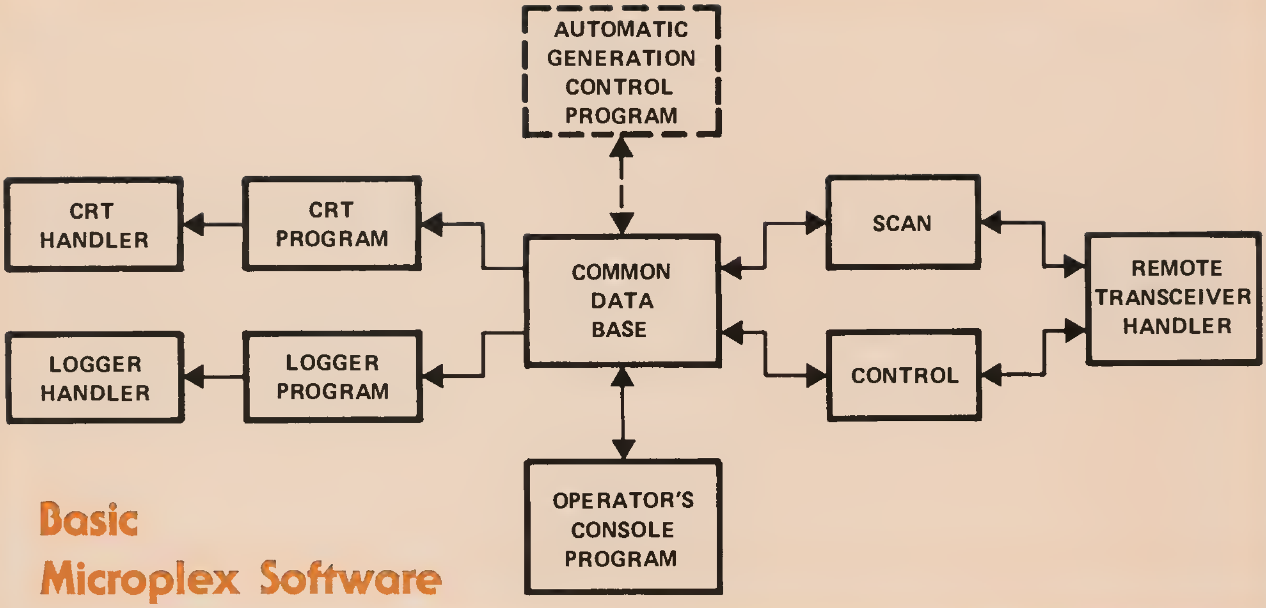
The Data Base is a listing of all points in the system with all of the information and data for each point reduced to a common, universal format. As the Remote equipment is scanned for status and data, the replies are checked for message security, translated into the common format, and used to update the Data Base.

There are three major functions which the MICROPLEX Software System performs. These are (1) 2-way communication between the Data Base and the Remote Equipment in order to perform data acquisition and control, (2) 2-way communication with the operator console, through which the operator can enter control commands and data and receive various indications, and (3) 1-way output of information from the Data Base to the CRT displays and loggers, which provide the operator with quickly accessible visual presentations of contents of the Data Base.

The Scan program specifically schedules scans of Remotes, and the Control program institutes request for control. The Remote Transceiver Handler honors scan and control requests, and executes them on the basis of assigned priorities, with control taking precedence. When a Remote replies to a scan request, the incoming information is placed in a raw data base. The new data is compared with that in the data base to determine whether there are changes in status, whether the changes constitute an alarm condition, and other such factors.

When the operator performs a point control sequence, the data base provides information as to allowable control functions, and is utilized to process the checkback data from the controlled point to determine that the device operated as commanded.

A major advantage to the concept of structuring all program functions around a common-format data base is that various types of applications programs can be tied into the system with access to the data base. Information can thus be obtained from the data base, processed, and the results of the calculations returned to other locations in the data base. Thus, in an AGC (Automatic Generation Control) program, a "station of information" can be designated into which the operator can enter high and low limits for specific units, fixed costs, rate limits, and other control information. The AGC application program accesses both operator-entered data and acquired data and outputs the results back to the data base. The operator can call up dynamic displays of these data base areas in the same manner as conventional station pages and the system treats the points exactly as if they originated at a Remote station.


AUTOMATIC GENERATION CONTROL PROGRAM
CRT HANDLER
CRT PROGRAM
COMMON DATA BASE
SCAN
REMOTE TRANSCEIVER HANDLER
LOGGER HANDLER
LOGGER PROGRAM
CONTROL
OPERATOR'S CONSOLE PROGRAM

Basic Microplex Software

One benefit of the universal data base format is that both the color CRT and the black and white CRT programs interface with the data base in an identical manner; therefore, the addition of a color CRT with one-line diagrams does not require changes to the AGC, Data Acquisition and Control, or Operator Console programs. Another advantage is that system modification and expansion can be performed by changing the data in the system descriptor tables and does not require additional support program coding.

Editing

The Core-Disk Edit program is a nonresident background program which provides a convenient method for adding, deleting, or modifying supervisory point information in the Master station computer. Certain types of on-line editing, such as those appropriate for access by other than system programming personnel, are performed at the ASR teletypewriter in a conversational mode. One-line color CRT diagrams are modified at the color CRT keyboard.

The following information can be modified or listed by the Core-Disk Edit Program:

a. System logging or display information
b. Station point record information
c. Core and Disk resident data used in the scanning process
d. Core and Disk resident data used to describe the supervisory system

Parameter inputs to the edit program are made through the programmer's I/O device or through a card or tape reader. Edit program inputs are checked for acceptability and reasonableness. If the input is determined to be in error, the values are flagged as such and the parameter string is again requested by the program.

Microplex Standard Software

Software for the Harris Slash series is fully tested and field proven. All processors are I/O independent, allowing them to be used under various operating systems.

The basic package supplied contains a MACRO assembler, link loader, debug utility, math library, utility processors, and diagnostic system. I/O handlers are provided for all standard peripherals.

An ANSI X2.9-1966 standard FORTRAN IV compiler is also available, along with a large complement of optional software.

BRIEF SPECIFICATIONS

Microplex Supervisory Control & Data Acquisition

MAJOR COMPONENTS	Operator console with control panel, CRT display; RO logger; Harris computer; Programmer's I/O; Supervisory logic.
Options	Individual station select buttons on operator panel; cursor or lightpen control; Disc memory; second console, second logger; line printer; card readers; Magnetic tape transport; Dual CPU's and fully redundant hardware; CPU-to-CPU channel; Color CRT(s) with 1-line schematics; Data trending; Video copier; Mapboard drivers.
HARRIS COMPUTER	General purpose, full-parallel binary arithmetic; single address, multiaccess bus structure; fully buffered I/O channels.
Word Length	24 bits
Cycle Time	450 nanoseconds.
Memory	MOS Memory/Battery backup/ Error correction; Max. 768K Byte memory in 48K Byte increments.
Registers	5 general purpose programmable; 3 hardware index registers.
Features	Hardware multiple, divide and square root. Memory area protected with changeable limits.
REMOTE INTERFACE	8 communications lines multiplexed to each transceiver.
Equipment Types	MICROPLEX 5000 Remotes, 5500 Remotes; other interfaces optional.
FUNCTIONAL MODES	Scan Remotes, limit-check analog data, check for digital alarms, report and log alarms, update CRT, respond to operator requests, compose and transmit commands to Remotes at operator direction, periodically log data and events.
Point Conditioning	Alarm inhibit/enable, alarm acknowledge, high/low limits set, select for control, control inhibit/enable.

HARRIS

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